

July 22, 1941.

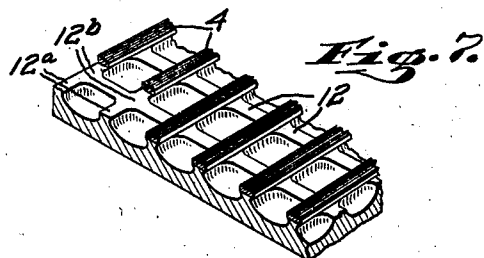
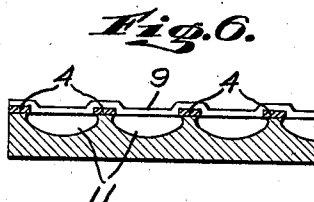
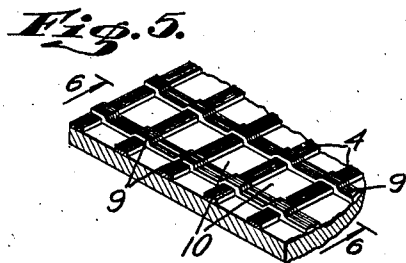
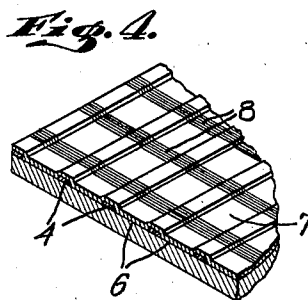
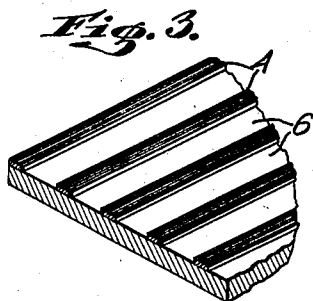
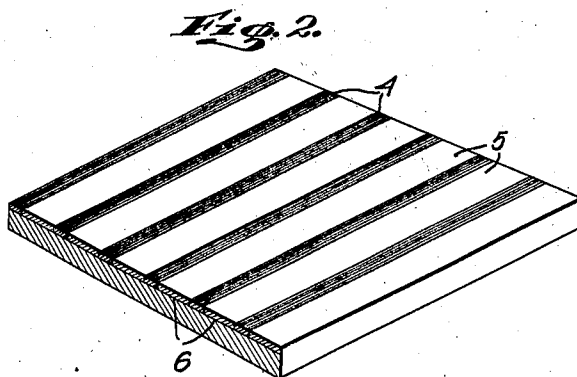
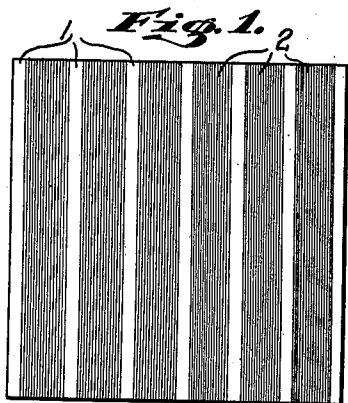
E. O. NORRIS

2,250,435

MATRIX FOR ELECTROFORMING FORAMINOUS SHEET

Filed April 25, 1938

2 Sheets-Sheet 1



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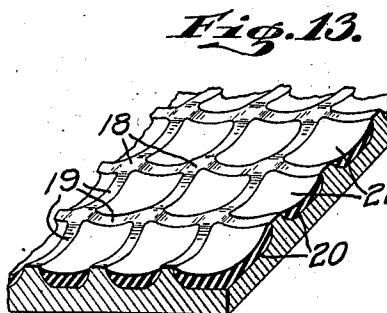
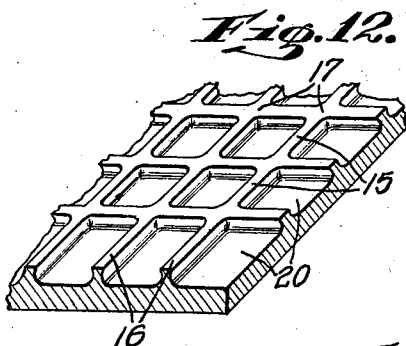
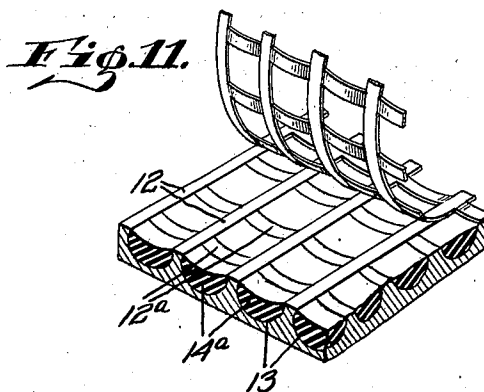
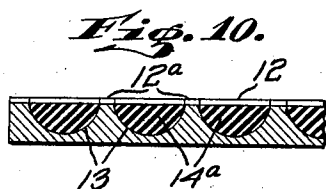
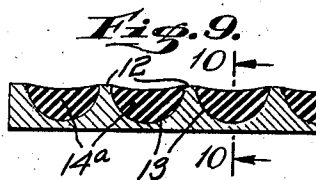
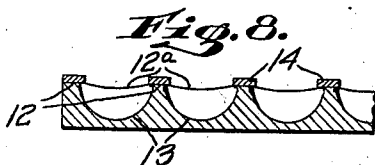
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MATRIX FOR ELECTROFORMING FORAMINOUS SHEET

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,250,435

MATRIX FOR ELECTROFORMING
FORAMINOUS SHEETEdward O. Norris, Westport, Conn., assignor to
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poration of New York

Application April 25, 1938, Serial No. 203,981

2 Claims. (Cl. 204—281)

This invention relates to the electroformation of reticulated sheet material, characterized by the fact that the strands or linking portions extending between junction areas are offset from the plane of the junction areas or some of them. Sheet of this pattern may generally be described as "foraminous sheet." More particularly, the invention relates to a matrix for electroforming such foraminous sheet, the process for making the matrix, and the product itself. The chief value in foraminous sheet of the character described arises out of the fact that sudden tensional stresses to which the sheet may be subjected are gradually absorbed in straightening or tending to straighten the offset portions and bring them into the plane of the junction areas.

Another object of the invention is the production of the above type of foraminous sheet of screen pattern of comparatively fine mesh, say one-fiftieth of an inch and smaller, a matrix for producing it, and a process of producing the matrix. However, I am not to be understood as confining myself to any particular dimensions, the utility of the invention depending mainly upon the conditions under which mechanical processes of manufacture become difficult or unduly expensive by reason of the increasing fineness of the work.

The application is in part a continuation of my copending application Ser. No. 52,334, filed November 30, 1935, Patent No. 2,166,366, and my co-pending application Ser. No. 179,460, filed December 13, 1937.

Referring to the drawings,

Fig. 1 is a plan view of a portion of a so-called "single line screen" composed of a glass plate exhibiting alternating bands 1 and opaque bands 2. While the plate of the absolute dimensions of opaque and transparent bands on the scale shown in this figure would be useful, it is preferable that this figure, as well as all other figures of the drawings, be considered as being on a scale very greatly enlarged as compared with the actual dimensions of a plate which would be used in work of the degree of fineness above referred to.

Fig. 2 shows a plate of metal the surface of which is covered with a light-sensitive film composed of a suitable vehicle such as gelatin, photo-engraver's glue, or transparent soluble gums impregnated with a light-sensitive salt such as bichromate of ammonium or potassium, the film having been photoprinted through the screen of Fig. 1.

Fig. 3 is a view of a portion of the plate of

Fig. 2 after the soluble portions of the light-sensitive film have been removed to expose the metal of the plate.

Fig. 4 is a view of the plate of Fig. 3 after the latter has been covered with a coat of light-sensitive shellac composition and a second printing made through a single line screen with its bands at right angles to the bands printed in the glue film.

Fig. 5 is a view of the plate of Fig. 4 after the soluble portions of the shellac composition film have been removed.

Fig. 6 is a view on the line 6—6 of Fig. 5 after the plate of the latter figure has been subjected to a suitable process to etch or otherwise produce pits in the plate over its exposed metallic areas.

Fig. 7 is a view of the plate of Fig. 6 after the shellac composition bands of the latter figure have been dissolved or otherwise removed leaving only the glue bands.

Fig. 8 is a view of the plate of Fig. 7 after it has been subjected to a second etching process.

Fig. 9 is a view of a matrix produced from the plate of Fig. 8 by removing the glue bands of the latter and filling the pits with a substance passive to electrolytic deposition.

Fig. 10 is a view on line 10—10 of Fig. 9.

Fig. 11 is a view of the surface of the matrix of Fig. 9.

Fig. 12 shows a plate produced from the plate of Fig. 6 by the removal of both the glue and the shellac bands without the interposition of the second etching step above referred to, and it illustrates a step in a modified process.

Fig. 13 is a view of a matrix produced from the plate of Fig. 12 by subjecting the latter to an etching process and filling the resulting pits with a substance passive to electrolytic deposition.

Fig. 14 is a perspective view of a portion of a screen produced from the matrix of Fig. 13.

The steps of the process will now be described in detail.

A plate of metal or other electrically conductive material is first covered with a light-sensitive film. A satisfactory film for this purpose may be composed of gelatin, photo-engraver's glue, albumen or soluble transparent gums rendered light-sensitive by association with some light-sensitive substance, of which a number are well known, such as ammonium, chromate or potassium bichromate. While I prefer sensitized photo-engraver's glue, the precise nature of the material of the film is not important nor essential to the invention, provided that it is light-sensitive and lends itself to the action of

some process which exerts a selective action that will effect removal of the material in those areas which have been shielded from light and resistance to removal over those areas which are exposed to light, and not soluble in the solvent for the second printing film presently to be referred to.

The single line screen of Fig. 1 is placed on the plate of Fig. 2 with the material of the opaque bands 2 in contact with the film, and the plate is exposed to a suitable light in the conventional manner, the result of which is to print bands 4 (if glue be used) of water-insoluble material, leaving bands 5 of water-soluble material—i. e., the transparent bands 1 of the screen allow the passage of light which renders the bands 4 insoluble, and the opaque bands 2 of the screen obstruct the passage of light leaving the bands 5 soluble.

The plate of Fig. 2 having been thus photoprinted, it is "developed" and "washed out," leaving the bands 4 superimposed on and adhering to the metallic surface 6 of the plate, which in turn appears in bands alternating with the bands 4.

The plate of Fig. 3 with its printed adherent and hardened bands 4 is next entirely coated with a film 7 of some light-sensitized material which is susceptible to development and washing out by an agent that selectively reacts on it to the exclusion of action on the metal of the plate and the hardened bands 4 of glue. Such a material, for example, is the light-sensitive shellac composition of the type sold commercially under the trade name of "Cold Top" which can be "developed" and washed out by a special reagent sold for the purpose under the trade name of "Cold Top Developer."

The plate thus prepared is again exposed to light through the single line screen of Fig. 1 or a similar or other screen selected according to the design to be produced, as will be later referred to. If the screen of Fig. 1 be used for the purpose, the bands 8 crossing the bands of hardened glue will be photoprinted on the film of shellac composition.

Next, the plate of Fig. 4 with its bands of hardened glue 4 and the photoprinted bands 8 in the shellac is developed and washed out by the selective reagent above-mentioned, leaving thereon the glue bands 4 and the bands of shellac composition 9 crossing over them, the metal of the plate being exposed over the areas 10 not covered by any of the bands.

The plate of Fig. 5 is then subjected to a process that will produce therein the pits 11 but will not affect either the glue bands 4 or the shellac bands 9. If the plate is of copper, a suitable chemical reagent is ferric chloride, but if preferred the same result will be accomplished by subjecting the plate to anodic action in a suitable electrolytic bath which, in the case of copper, could consist of a solution of copper sulphate and sulphuric acid.

The plate of Fig. 6 may then be subjected to the action of a suitable reagent that will remove the printed bands 9 of shellac composition but which does not deleteriously affect the glue nor the material of the plate. A suitable agent for this purpose may be concentrated alcohol which acts as a solvent on the bands 9 of shellac composition. Fig. 7 clearly shows the pitted plate with the lands 12 exposed by the removal of the shellac and the lands 12a and the cross-over areas 12b covered by the glue bands 4.

The next step comprises again subjecting the plate to the action of a suitable agent that will take off material from the exposed lands 12 in order to lower them below the level of the junction areas 12b. This may be accomplished, as in the case of producing the pits 11, by subjecting the plate to a chemical etching reagent or to anodic action in a suitable electrolytic bath. The lands 12 are thus etched somewhat to the contour indicated by 13 in Fig. 8. At the same time, of course, the walls of the pits are somewhat etched, although not to a material or objectionable extent.

The glue bands 14 may then be removed by the application of a suitable reagent which does not affect the material of the plate to an objectionable extent, for example, caustic soda. After thorough cleaning, the pits are then filled flush to the edges of the surrounding lands with passive material 14a, such as Bakelite, asphaltum, or shellac, the result being a matrix as shown in Fig. 11 exhibiting an exposure surface comprising a depositing area of grid pattern and non-depositing areas in the voids of the grid. The connecting lands 12 of the depositing areas curve downwardly from the junction areas and the surface may be described for convenience as of undulate contour. After applying a stripping film to this matrix—such, for example, as very dilute wax—and employing it as a cathode in a suitable electrolytic bath, the deposit laid thereon will have the pattern and contour of the lands of the matrix and may be readily stripped therefrom.

Instead of proceeding in the manner described with reference to Figs. 3-11, the process may be varied from the point described with respect to Fig. 2 by rotating the single line screen so as to crossprint bands on the glue film of the plate of Fig. 2 after the manner described in my application S. N. 179,460, filed December 13, 1937. In other words, the bands 4 are first printed on the gelatine film on the plate 2 and the screen is then rotated so that it prints similar bands at right angles to the bands 4. The plate may be then developed and washed out, and pits etched in the exposed metal areas, and the glue top removed, resulting in a plate similar to that shown in Fig. 12. The plate of Fig. 12 may be then subjected to further etching in ferric chloride as above described, with the result that the lands 15 and 16, possessing sharp edges and being relatively narrower than the junction areas 17, are much below the level of the latter, the surface exhibiting a contour of raised junction areas 18 and depressed connecting lands 19. After filling the pits 20 with passive material 21, as has been hereinbefore described and after properly rubbing off so that the lands will be exposed, the plate of Fig. 13 may be used cathodically as a matrix in a suitable electrolytic bath, and screen or foraminous sheet may be deposited thereon conforming to the pattern and contour of the lands as shown in the figure.

In the foregoing description of the invention I have used the term "single line screen" and also the terms "etch" and "etching." In using the term "single line screen," I am merely following the nomenclature of the photoprinting art, the term "single line screen" being conventionally applied to a screen exhibiting a pattern of adjacent bands (as I prefer to term the so-called lines) alternately transparent and opaque. This term is used in contrast to the term "crossed line screen," which exhibits a pattern that in effect

is the result of superimposing one single line screen on another with the alternately transparent and opaque bands of the second screen crossing those of the first. In using the term "etching" I intend that it shall include not only etching in the sense in which the word is frequently used—viz., removing material from the surface of a plate by the simple application of chemical reagent, but also (which is an equivalent process for most purposes) making the plate anodic in a suitable electrolytic bath to effect dissolution of the material of which it is composed.

In employing the matrices of Figs. 11 and 13 for the production of foraminous sheet, it is necessary, in order to prevent adherence of the deposit, that the deposit receiving surfaces be rendered non-adherent to the deposit. This may be accomplished in a number of ways, one of which is by the application of a very thin film of wax dissolved in benzine, gasoline or other solvent, preferably of the highly volatile type. While a conductive surface covered with such a substance will receive a deposit, the deposit will not adhere to that surface with sufficient tenacity to prevent it from being readily stripped therefrom.

In the pattern of the particular single line screen that I have described, the opaque bands are shown as considerably wider (in fact almost three times wider) than the transparent bands. These dimensions, however, are selected partly because they are illustrative and partly because they have been found suitable for producing matrices for the electroformation of many desirable types of screen. The relative or absolute dimensions of these bands can however be varied to suit the particular purpose in hand—for example, for the ultimate production of screen of relatively small holes and wide lands or any other relative or absolute dimensions desired.

Again, the opaque and transparent bands of the screen of Fig. 1 are shown as being geometrically parallel. This pattern is selected likewise because it suits the particular purpose to

which I have practically applied the process, viz., to the production of screen with approximately square holes regularly arranged in rows and columns. Parallelism of these bands is not however essential to the invention, as the same principles would apply if they were made non-parallel, such as of an ogee pattern or otherwise.

I have described above certain embodiments of my invention and a preferred process with certain modifications thereof, but I wish it to be understood that these are illustrative and not limitative of my invention and that I reserve the right to make various changes in form, construction, and arrangement of parts and also to make various changes in process of manufacture falling within the spirit and scope of my invention as set forth in the claims.

I claim:

1. A matrix adapted to serve for the electroformation of foraminous sheet, said matrix having an exposure surface which comprises a deposit-receiving area of grid pattern, the areas of which between the junction areas curve away from the plane of said crossing points to an archlike form, the planes in which the curves lie being normal to the surface of the matrix and the remaining portions of said exposure surface consisting of material that is passive to electrolytic deposition.

2. A matrix adapted to serve as a cathode for the electroformation of foraminous sheet, said matrix having a deposit-receiving surface area which comprises a multitude of crossed bands arranged to present a screen pattern and having the property of receptivity to an electrolytic deposit, the portions of the bands intermediate the crossing points curving away from the horizontal plane of such crossing points to an archlike form, the plane of the arch being normal to the surface of the matrix, and the remaining portions of said surface not occupied by the bands consisting of material that is passive to electrolytic deposition.

EDWARD O. NORRIS.